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Defining an Epidemic: The Body Mass Index (BMI) in British and American obesity research 1960-2000

Abstract

Between the 1970s and the mid 1990s, the body mass index (BMI) became the standard means of assessing obesity both in populations and in individuals, replacing previously diverse and contested definitions of excess bodyweight. This paper draws on theoretical approaches from the sociology of standards and science and technology studies to describe the development of this important new standard and the ways in which its adoption facilitated the development of obesity science, that is, knowledge about the causes, health effects and treatments of excess body weight. Through an analysis of policy and healthcare literatures, I argue that the adoption of the BMI, along with associated standard cut-off points defining overweight and obesity, was crucial in the framing of obesity as an ‘epidemic’. This is because, I suggest, these measures enabled, firstly, the creation of large datasets tracking population level changes in average body weights, and, secondly, the construction of visual representations of these changes. The production of these two new techniques of representation made it possible for researchers in this field, and others such as policymakers, to argue credibly that obesity should be described as an epidemic.

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Introduction

Each standard has its own history, and it is the specificity of that history that makes the standard a compelling topic of social analysis (Timmermans & Epstein, 2010: 75)

This research analyses the growth of scientific and policy knowledge about obesity and overweight. Since the late 1990s, obesity has been routinely described as an epidemic and a significant threat to global health (Government Office for Science, 2007; WHO, 2000; WHO, 2004) and the use of the body mass index (BMI) to both define and measure excess body weight is central to such accounts. Like many other indices of bodily measurement, such as blood pressure (Timmermann, 2006), BMI functions as both the measurement of a bodily attribute (weight related to height) and also the definition of a condition (obesity/overweight). This dual role makes an analysis of its function within obesity science crucial, since it simultaneously measures and defines the modern problem of excess body weight.

The development of BMI-based definitions of overweight and obesity, in British and American obesity research and public health policy, were crucial in the framing of increasing rates of obesity and overweight as an important public health problem i.e. an epidemic. The use of this simple numerical index allowed increasing rates of excess bodyweight to be tracked in individuals and populations, and the results of such studies to be straightforwardly presented. In order to make this argument, I first outline conceptual approaches to the analysis of standardisation from medical sociology and science and technology studies (STS). I then describe my analysis of the development of the BMI in recent British and American research and public

health policy. My aim is to examine the reasons for the adoption of the BMI within chronic disease epidemiology, especially the areas concerned with the relationship between bodyweight and health, by highlighting the practical advantages this new index had for researchers, in conducting their research, and in framing arguments that increasing average body weights were a major public health problem requiring urgent government action.

Background/theoretical approach

Knowledge about the causes, effects and treatment of excess bodyweight – here labelled ‘obesity science’ – is a hybrid entity (Jasanoff, 1990: 227) that is profoundly shaped by, and constitutive of, health policy. Obesity science is a synthesis of the results of laboratory, clinical and epidemiological research, previous public health policy and contemporary common sense, into a form of knowledge that is relevant to public health policymaking. Virginia Berridge (1999, 2005, 2006 and 2007) has described such the development of scientific knowledge about the health impacts of smoking in post-war British public health policy. This knowledge often develops as part of researchers’ work as members of expert committees and authors of official reports; the committee room has been described as an understudied arena of knowledge creation (Smith, 1995: 280).

At the intersection of STS and medical sociology, several authors have written about processes of developing and adopting standards (for example Bowker & Leigh Star, 1999; Epstein, 2007; Timmermans & Almeling, 2009; Timmermans & Berg, 2003; Timmermans & Epstein, 2010). The centrality of scientific and technical expertise to

creating and maintaining standards has made standardisation an important topic in STS (Timmermans & Epstein, 2010: 73). Classificatory systems and the standards contained within them are used to create order amongst phenomena and are ‘one of the most important tools used in biomedicine’ (Pickersgill, 2011a: 73). Within medical research, they ‘ensure stability of meaning over different sites and times, and are essential to the aggregation of individual health data into larger wholes’ (Timmermans & Berg, 2003: 24). Standards can be considered as technologies, as ‘artefacts that enable problems to be solved and work to be performed’ (Pickersgill, 2011b: 555). The creation of standards can be seen as a method of managing uncertainty that can stimulate both novel ways of working and the production of new types of knowledge (Pickersgill, 2011a: 73-75).

Medical sociologists have often analysed processes of standardisation within medicine with the assumption that these processes are harmful to patients (Timmermans & Almeling, 2009: 21). In a similar fashion, external, often social scientific, critics of obesity science argue that the BMI-based definition of overweight and obesity is an inadequate measure of cardio-vascular risk, and that its use leads to inappropriate medical treatment (Bacon, 2008; Campos, 2004; Gaesser, 2002; Gard & Wright, 2005; Monaghan, 2005; Oliver, 2006). Busch (2000) argues that grades and standards operate as a moral economy, by defining good or competent individuals and disciplining those who do not conform (see also Bowker & Leigh Star, 1999). Due to the moral weight given to ideas of appropriate conduct for health and wellbeing (Crawford, 1980), and their framing in terms of a meta-narrative of ‘decadence and decline’ (Gard & Wright, 2005: 2), biomedical bodily standards often function powerfully in this fashion. The above critiques also argue that contemporary

scientific understandings of excess bodyweight contain moral and aesthetic, rather than medical, judgements about appropriate body size.

Whilst acknowledging the validity of many of these analyses, in this article I aim to follow the approach of Timmermans and Ameling (2009) in providing a more descriptive account that aims at a sociological analysis of the making of the BMI rather than a critique of it. Standardisation is often undertaken as a means to achieve common goals rather than an end in itself (Timmermans & Almeling, 2009: 27), but the embedding of standards necessarily has consequences for everyday practices (Timmermans & Berg, 2003: 23). Because of these practical effects, work needs to go into the maintaining standards (Bowker & Leigh Star, 1999; Busch, 2000), and, if this work of implementation is not done, variability has a tendency to return as standards start to proliferate (Timmermans & Almeling, 2009: 25). Thus, the ‘objectivity, universality, and optimality’ of each standard are ‘hard won victories that can be heavily contested by third parties lobbying accusations of bias and politicization’ (Timmermans & Epstein, 2010: 74). The following account provides a sociological analysis of the work which went into the development and maintenance of the BMI, rather than attempting to empirically assessing its adequacy as a measure of health.

Two processes within post-war medicine are crucial to my account. The first is the growing use of statistics, especially within chronic disease epidemiology, out of which obesity science developed. The increasing use of statistical methods within epidemiological research meant that numerical indices became important in the framing of convincing arguments for the existence of a health problem (Berridge, 2007; Rothstein, 2003), and the development of the BMI has been discussed as part of

this body of writing (Hacking, 2006b). The second is the increasing promotion of practices of evidence-based medicine since the 1980s, which can be understood as an intensification of attempts to standardise medical practice (Timmermans & Berg, 2003). The medical profession adopted many of the practices of evidence-based medicine partly in order to maintain its professional autonomy in the face of government attempts to restrict the growth of healthcare costs (Timmermans & Berg, 2003: 16). The development of the BMI was part of this trend, but, as I illustrate elsewhere (Fletcher, 2012), arguments about increasing healthcare costs were also a crucial element in the framing of excess bodyweight as a major public health problem.

Methods

Principal primary sources for this research were a series of reports and textbooks produced by British and American researchers/policymakers writing on nutrition and health between 1969 and 2000.¹ This collection of sources was developed using a snowballing strategy, involving extended searches of databases e.g. Web of Knowledge, Medline and COPAC and cross-referencing publication bibliographies. As advisory documents produced on a consensus basis (Hilgartner, 2000: 23) or authoritative statements of research knowledge (Kuhn, 1970: 43), such publications can be used to examine the development of an accepted body of policy-orientated knowledge like obesity science. My analysis also draws on secondary sources, such as recent accounts of the development of risk factor epidemiology (Aronowitz, 1998a; Oppenheimer, 2005 ; Oppenheimer, 2006; Rothstein, 2003)

This body of data was analysed in order to identify recurring themes, such as the prevalence rates of excess bodyweight cited, its definition and measurement, and the proposed causes and treatments. Such knowledge claims were tracked over time, tracing how successive documents re-iterated this body of knowledge and developed it. This approach enabled an analysis of how the understandings of excess body weight mobilised by obesity science slowly evolved. A key advantage of this form of document-based research (as opposed to, for example, oral histories) is that it avoids the presentation of retrospective narratives framed in terms of truth and discovery, and enables a more accurate focus on the development of expert knowledge within its contemporary context.

The Development of the Body Mass Index

Before the BMI

Initial data on the health consequences of excess body weight came from the insurance industry in the early 20th century. The American Metropolitan Life Insurance Company developed its statistical tables of ideal weights after their research identified an association between high body weight and an increased risk of mortality. These findings went against then contemporary medical orthodoxy which regarded overweight individuals as healthy, and underweight individuals as potential tuberculosis sufferers, but medical directors of insurance companies were more concerned with profits than aetiology, and so they accepted this new and unexpected relationship (Rothstein, 2003: 64). The company's use of weight in the selection of policyholders made 'build' - a measure that combined height and weight (Rothstein, 2003: 64) - one of a set of important medical risks that also included high blood

pressure and a history of diabetes or kidney disease (Rothstein, 2003: 73-4). Their statisticians used relative weights (i.e. relative to height) to produce a range of categories: average weight, overweight (greater than 110% of average weight), and obese (greater than 120% of average weight). The weight ranges for specific height and frame sizes were then correlated with mortality data to give ranges of “ideal weights” – in the 1959 tables the desirable weight range for a 5’6” inch woman was 124 to 156 pounds, depending on whether they were small, medium or large framed (OHE, 1969: 4-5). These tables were constructed from one of the largest existing collections of data on the relationship between bodyweight and mortality, and were widely used by British and American researchers until other sources of data became available (as further discussed below).

Between the 1920s to the 1950s, rising rates of coronary heart disease became an important policy concern in the US, leading to significant increases in funding for research (Fye, 1996: 102-3, 181). Some of this funding was used to develop a new research method, the large-scale cohort study, to investigate what later became known as ‘risk factors’ for heart disease (Aronowitz, 1998b; Oppenheimer, 2005 ; Oppenheimer, 2006). Once established, two of these studies - the Framingham Heart Study and the Seven Countries Study – became iconic within American chronic disease epidemiology (Kromhout et al., 1994; Oppenheimer, 2005). In the 1950s, the scientific status of British epidemiology and the knowledge it produced was also still uncertain (Amsterdamska, 2005; Berridge, 1999: 66). However, partly due to parallel changes in population health, these research pre-occupations were taken up by British researchers in the 1950s and 1960s, and these early obesity researchers normally used the Metropolitan Life weight table categories to define obesity and overweight.

Uncertainty in early obesity science

The 1960s and 1970s were the early period of British obesity science, and at this time producing non-contested measures of obesity was difficult, since it was not yet seen as a unitary entity with a single cause:

Obesity is neither one condition nor one disease. The fat baby, the fat adolescent girl, the woman who gets fatter after each pregnancy, the traditional example of the fat business executive – these all have fatness in common, but it is very doubtful if the aetiology and natural history are the same in all of them (see also Bray, 1979a: v; DHSS/MRC, 1976: 1).

Despite this uncertainty, it was strategic for researchers in this field to provide an appropriate numerical measure so that the incidence of obesity could be measured, and it could be framed as a public health problem. However, competing definitions and measures of obesity, some of which were difficult to convey concisely, made this difficult for them to do. Researchers sometimes modified the Metropolitan Life definitions: one author defined obesity as weighing 10% above ‘normal’ or ‘desirable’ weight, whilst mentioning that others used a figure of 15 or 20%, and defined ‘excessive’ obesity as weighing 20% above the desirable weight, again mentioning that others used 30% as an appropriate figure (Craddock, 1969: 2 - 3). Another referred to Seltzer’s ‘ponderal index’ - defined as the ratio of the height in inches divided by the cube root of the weight in pounds - but also used tables from the Framingham Study that referred to relative weights (Baird, 1969: 17-19) and in the late 1970s, one textbook was still using categories from insurance company tables:

For practical clinical purposes it is convenient to take the range of “desirable weight” from life insurance experience, from the lower end of the small frame to the upper end of the large frame (since frame size is undefined), and accept that people above this weight are obese (Garrow, 1978: 149).

In 1977, the authors of one report distinguished between two different ways of measuring obesity – relative weight and numerical indexes, such as W/H^2 , which are more absolute because they do not refer to population averages. Relative weight measures derived from insurance company data were thought to be problematic since they referred to an unrepresentative sub-group of the population (DHSS/MRC, 1976: 3 - 4), but despite these arguments, the Metropolitan Life ideal weights were still standard, and other measures, such as W/H^2 (see next paragraph below), were discussed with reference to them:

A cut-off point often used for separating obese from non-obese is a relative weight 120% of the “desirable” weight. This corresponds to values for W/H^2 of 27.5 for men and 27.0 for women of medium frame size and 29.9 for men and 29.5 for women of large frame size (DHSS/MRC, 1976: 4).

Thus, before the widespread adoption of the BMI, there were several different, competing definitions and measures of overweight used in early obesity science, including the Metropolitan Life ideal weights, but also a number of precursors to the BMI which did not become widely used in the UK or the US - such as W/H , W/H^3 (the ponderal or Rohrer index) and $W = H-100$ (the Broca index). Some of these indices were specific to particular research studies or authors, even if they were based on the Metropolitan Life tables, and there was not yet one agreed alternative to ideal weights. There seem to have been disciplinary and regional patterns in these usages: W/H^3 was used in paediatrics, while epidemiological researchers in mainland Europe used the Broca Index until relatively recently (Oddy et al., 2009). Often authors used a definition based on the Metropolitan Life ideal weights and referred to other indices as they incorporated results from different studies into their research. This combination of varying indices of measurement with varying definitions of overweight or obesity led to a large number of competing definitions – one article lists

18 different classifications used in the US between 1942 and 2000 (Kuczmarski & Flegal, 2000: 1076). Early American and British obesity science was, therefore, characterised by an uncertainty about the nature of obesity and overweight, as well as a number of competing indices for measuring it.

The BMI is proposed by American researchers

The body mass index - calculated using the formula W/H^2 - was suggested as a new index of excess bodyweight in 1972 and over the next twenty years, it became the standard index. W/H^2 had been first developed by the Belgian statistician and astronomer, Adolphe Quetelet, in the early nineteenth century, but Quetelet's interest was in comparing populations, so he did not use W/H^2 to assess individuals (Desrosieres, 1998, Hacking, 2006b). Ancel Keys, an eminent epidemiologist and the lead investigator of the Seven Countries Study, argued that W/H^2 was the most useful of the available indices of relative weight, and suggested that it be re-named the body mass index or BMI (Keys et al., 1972). Using data from the Seven Countries Study, Keys and his co-authors compared the usefulness of W/H^2 to that of W/H , the ponderal index (W/H^3) and percentage above average weight, concluding that W/H^2 was superior on two counts. First, W/H^2 was less sensitive than W/H to variations in population height and so provided a better measure of overweight, rather than simply of stature. Secondly, W/H^2 was found to have a high correlation with skinfold thickness and body density (which were used to estimate body fat). BMI was thus, 'if not fully satisfactory, at least as good as any other relative weight indicator as an indicator of relative obesity' (Keys et al., 1972: 339). This was not a particularly enthusiastic endorsement, but W/H^2 had one additional advantage: it provided both a

very clear index of changes in the weight of an individual, and an effective means of comparing the obesity of individuals of different heights but of the same weight:

Consider a man 1.70m who weighs 60 kg and then gains 15kg. He gains 25% in weight; his value of W/H changes in the same proportion, his body mass index W/H^2 changes from 20.76 to 25.95, i.e. it increases by 25% also. But his ponderal index changes only from 2.3029 to 2.4807, an increase of only 7.7 per cent. Now consider two persons of the same weight of 60kg, one is 1.70m tall, the other 1.45m in height. The ponderal index of the shorter person is $(2.700)(2.303) = 117.2$ per cent that of the taller person, while the percentage comparisons using W/H , W/H^2 and W/H^3 are 117.2, 137.4 and 161.1 respectively (Keys et al., 1972: 340).

BMI was seen as a relatively sensitive and discriminating measure of relative body fat that could be usefully applied in situations of increasing average body weights both to describe population changes, and to compare the relative weights of different individuals.

However, in order to make full use of this new index, a shared definition of obesity and overweight was also needed. Such a definition, a classification of body weights based on BMI values, was proposed by George Bray, another well known American researcher, at the first international conference on obesity in 1979, in Bethesda, Maryland. The introductory chapter of the conference proceedings included the first of the BMI classification systems summarised in table 1, and a subsequent chapter outlined the advantages of the BMI over other indices:

Various indexes involving height and weight have also been tested. However, they can never provide anything more than an index of overweight, since they falsely suggest that a muscular football lineman is obese and they fail to characterize a patient with atrophic muscle mass and increased body fat. The so-called body mass index (weight/height²) ... has the highest correlation with independent measures of body fat; but in some series this may be as low as 0.6 or less (Sims, 1979: 24).

Evidently, the contributors to the 1979 conference were also aware that their chosen index of obesity was imperfect, but a numerical index such as BMI had a variety of useful functions (see below), and so they appear to have made a pragmatic choice from the available options. Ancel Keys and George Bray were influential researchers, working in fields central to obesity science, and I now go onto to describe how their BMI-based definition of obesity and overweight was gradually adopted by other researchers.

The BMI is adopted in Britain

Strong links between British and American obesity researchers in this period meant that Bray's BMI-based definition of obesity and his classification scheme was readily adopted by British researchers. Presumably the adoption of the BMI also helped consolidate a relatively new research field in the UK. John Garrow, an eminent British researcher, developed subsequent versions of the BMI-based definition of overweight and obesity in a series of textbooks on the physiological mechanisms governing human body weight (Garrow, 1978; Garrow, 1981; Garrow, 1988; Garrow & James, 1993). In his 1978 textbook, Garrow referred to BMI in a discussion of ideal weight ranges but did not use BMI cut-off points to define obesity and overweight. The classification shown in table 1 first appears in his 1981 textbook, was re-printed unaltered in later textbooks and reports. In the late 1980s different classification systems were still circulating. For example, due to the different definitions embedded in different datasets, Philip James (1984: 636), used Garrow's classification when writing in 1984, but in a later article refers to cut-offs based on US National Health and Nutrition Examination Study (NHANES) data and percentages of ideal weights taken from the Metropolitan Life tables (James, 1988: 90 - 94).

However, by the mid 1990s the BMI had become the standard method of both measuring and defining obesity. The previous diversity of definitions and measures was replaced by a situation where overweight and obesity was defined and measured solely in terms of a BMI classification derived from Garrow's 1988 textbook (BNF, 1999: 6-7; DoH, 1995: 3; West, 1994: 7). Such standard usage made previous discussions of the relationship between body fat and obesity, or of alternatives to BMI, largely irrelevant. Glossing over the work involved in its development, the BMI was now described as a 'relatively simple index of body fatness' that was useful because 'in general [it] is relatively height-independent, i.e. short and tall people of similar proportions but very different weight have similar BMIs' (DoH, 1995: 3). This consensus was also reflected by the partial adoption of BMI-based definitions of obesity and overweight by the WHO in a technical report on anthropometry (WHO, 1995). Indeed, by the late 1990s the BMI was sufficiently well established that its history was being outlined in reports:

There is international consensus that tables showing weight-for-height can conveniently be replaced by a single index. The Belgian astronomer Quetelet observed in 1869 that, among adults of normal body build, weight was proportional to the square of height; in other words weight in kilograms (kg) divided by the square of height in metres (m)² was constant. Keys *et al.* (1972) made a similar observation and named the relationship Body Mass Index (BNF, 1999: 4).

The BMI was seen to derive prestige both from its origins in Enlightenment science and its re-invention by modern epidemiological research. Furthermore, John Garrow's high profile, both as a researcher and an expert committee member, presumably aided the adoption of the BMI through the 1980s and 1990s.

Table 1: Comparison of different BMI classification schemes showing different categories, BMI ranges and descriptions

CLASSIFICATION SCHEME	Category	BMI range	Description
GEORGE BRAY (Bray, 1979b: 6)	Women	BMI > 30	obese
		BMI > 23.5	overweight
		BMI > 18.5	acceptable
	Men	BMI > 30	obese
		BMI > 25	overweight
		BMI > 20	acceptable
JOHN GARROW (Garrow, 1981: 2)	Grade III	W/H ² > 40	
	Grade II	W/H ² 30-40	
	Grade I	W/H ² 25-29.9	
	Grade 0	W/H ² 20-24.9	
MID 1990S VERSION OF GARROW'S SCHEME (West, 1994: 7)	Grade 3	BMI > 40	severely obese
	Grade 2	BMI 30-40	obese
	Grade 1	BMI 25-29.9	overweight
	Grade 0	BMI 20-24.9	desirable weight
	Ungraded	BMI < 20	underweight

Producing the standard cut-off points

Nevertheless, merging Bray and Garrow's classification schemes with data from epidemiological research was an ongoing and complicated process involving debates about whether the same limits should apply to men and women, or to different age groups. The 1994 Office of Health Economics report on obesity, gave a definition of obesity based on Garrow's 1981 classification (see table 1), but the author argued that

It has been suggested that a different BMI scale be used for women, with BMI 18-23 regarded as desirable, BMI 23-28 considered overweight and BMI over 28 judged to be obese (Bray 1979) ... A clear case can be made for the interpretation of obesity changing with increasing age. Among Finnish men over 80 years the highest five-year survival was among those with a BMI of over 30 (West, 1994: 7).

Similar arguments were also made about different cut-off points for different population groups (WHO, 1995; WHO, 2000). BMI cut-off points also had an explicit age-related normativity built into them as they were based on the average weights of young adults:

The 20-29-year-old group was used as a reference population because young adults are relatively lean and the increase in body weight which ordinarily occurs in men and women during ageing is almost entirely due to fat accumulation (VanItallie & Woteki, 1987: 40).

The fact that ageing had been found to lead to weight gain did not mean that definitions of overweight and obesity should be adjusted to reflect this. In one study, the BMI associated with lowest mortality increased from 21.4 among men aged 20-29 to 26.6 for those aged 60-69 (for women the comparable figures were 19.5 aged 20-29 and 27.3 at age 60-69) (Garrow, 1988: 3). Despite this evidence, Garrow argued against allowing for an increase in the desirable weight ranges at later ages:

It cannot therefore be concluded that there is no disadvantage to an old person being overweight, since exercise tolerance and mobility may be greatly impaired by excess weight in an elderly person with degenerative disease of weight-bearing joints. In practice, therefore, the classification given above of grades of obesity serves quite well, at least over the range 20-65 years (*ibid.*).

Later authors continued to make the point that ideal body weights were in this range of BMI 20 to 25, irrespective of gender or age. There was seen to be no health benefit from weight gain by adults, rather ‘there is good evidence that, for an individual, minimum mortality is associated with a constant weight between the ages of 20 and 50 years’ (BNF, 1999: 4). This reflects the new importance given to weight stability in this period (SIGN, 1996; West, 1994: 20; WHO, 2000: 201-2). These continuing discussions suggest that the process of standardising the definition was partial and incomplete, and also illustrate the ways in which the definition of excess bodyweight tended to proliferate, despite the work that went into maintaining a standard definition (Timmermans & Almeling, 2009: 25).

The BMI cut-off points used by these researchers to define overweight and obesity were derived from plots of mortality rates against BMI, which were often described as having a “bathtub” or a “J-shaped” shape, where BMI 30 or 31 marked a point of significantly increased risk as the curve became much steeper. In the 1970s and 1980s these derived from American research, such as the Build and Blood Pressure Studies of 1959 and 1979, the Framingham Study or the American Cancer Study of 1979 (Hautvast & Deurenberg, 1987). By the 1990s there were also British data - including a seven year study of 18 400 civil servants - which showed that for men ‘at age 45 BMI over 30 carries about three times the mortality risk of BMI 20-25’ (West, 1994: 14). The author compared the health consequences of smoking with those of overweight and obesity:

A non-smoker, for example with a BMI 20-25 would have to increase his or her weight to BMI over 30 in order to experience the same mortality risk as a person with BMI 20-25 who smokes 20 or more cigarettes a day (West, 1994: 13).

Assessment of the association between mortality and bodyweight had been difficult due to the effect of several confounding factors, including the health effects of smoking: ‘smokers tend to be lighter than non-smokers and to die younger, so when studied in a population mixed with non-smokers they distort the true relationship of weight to mortality’ (Garrow, 1988: 11). The complexities of disentangling these relationships and identifying the correct causes of disease to be included in the specification of ideal body weights had led to extended discussions of the links between smoking, weight and mortality (Garrow, 1981; Hautvast & Deurenberg, 1987; James, 1984; RCP, 1983), and also to repeated comparisons between the health risks of smoking and those of excess body weight. In later reports, such evidence was used to argue for stringent standards of ideal body weight:

Epidemiological studies which do not take account of smoking behaviour may not reflect the risk associated with being overweight because overweight non-smokers survive better than thin smokers. Smokers die early and account for much of the increased mortality of the thinnest people in the population. This has led to inaccurate suggestions that weight gain in middle age is conducive to better health (DoH, 1995: 4).

Moreover, analysis of data from another large-scale study seemed to show a different relationship since, when smokers and ex-smokers were taken out, the J-shape of the curve disappeared: ‘the J-shaped curve, with a nadir....of a BMI of about 25, is caused by deaths among smokers or among those with pre-existing disease’ (BNF, 1999: 5). The shape of the mortality curves was thus defined as an artefact resulting from confounding factors, rather than an expression of a “true” relationship between weight and health.

Presumably partly because of the successful development of anti-smoking public health policies, direct comparisons of the effects of obesity and smoking were a routine element of these discussions. Another report argued that ‘the mortality risk of a normal-weight adult smoker exceeds that of non-smokers with a BMI of 30-35’ but continued: ‘both smokers and non-smokers, considered separately, show the lowest mortality rates in the 18.5-24 range of normal BMI. Long-term follow-up of non-smoking adults suggests an optimum BMI of 20 or less’ (SIGN, 1996: 10). This comparison was made only for illustrative purposes, not as part of a treatment argument, since, in the same paragraph, the authors argued that stopping smoking was a priority even if it resulted in weight gain. As well as allowing researchers to assign different causes to deaths among the underweight, repeated comparisons with smoking - an increasingly stigmatised and marginalised habit that was framed as the

result of individual choice - invited the inference that weight gain was also voluntary and resulted from individual ignorance and poor food choice.

The increasing availability of large-scale epidemiological data

The existence of a shared definition of obesity was also a crucial element in the collection and analysis of data about the prevalence of excess bodyweight. The adoption of BMI and increasingly standard categories resolved the problem of comparing data from different surveys which previously had used differing definitions or measurements of overweight and obesity. However, it was not until the 1980s that British researchers had access to large-scale epidemiological data on body weights from national studies, as well as from the initial results of the WHO MONICA (Multinational MONItoring of trends and determinants in CARDiovascular disease) project (Tunstall-Pedoe, 2003). One 1985 survey of approximately 10 000 members of the British adult population showed that 40% of men and 32% of women are 'obese to some extent' (Garrow, 1988: 5). Evidence for increases in average body weights also began to be cited in British government reports: 1991 data from a Department of Health report gave rates of obesity as 13% for men and 15% for women, and rates of overweight as 40% for men and 29% for women, suggesting that over 14 million adults were overweight and 6 million obese (West, 1994: 11). Increasing production and graphing of projected trends in average body weights was being used to frame obesity as a problem that had been increasing since the 1980s, and would carry on increasing at the same rate, for at least the next two decades (DoH, 1995: 5-6), with the situation in the US seen as a forecast of future problems in Britain.

As Table 1 (above) demonstrates, BMI-based definitions of overweight and obesity consist of two elements – the BMI index, and the cut-off points which are used to define the levels at which body weight was considered to be excessive and a danger to health. Even in the 1980s and 1990s when the BMI had become widely used, the specific cut-off points used varied between studies. For example, a US National Institutes of Health conference in 1985 decided on a cut-off point for obesity as BMI ≥ 27.8 for men and ≥ 27.3 for women (NIH Panel on Obesity, 1985) whereas most British research was then using overweight BMI ≥ 25 and obesity BMI ≥ 30 for both sexes. This lack of standardisation of BMI cut-off points was part of a much wider set of disagreements about how to define obesity, by using percentages above average body weight (the NIH definitions) or increases in mortality risk (the Bray/Garrow definitions). But in the late 1990s, the cut-off points used by the US government were changed. Using the existing NIH cut-off points, the prevalence of overweight among the adult population was 33.3% for men and 36.4% for women, but when Bray's and Garrow's cut-off points were applied the prevalence figures became 59.4% for men and 50.7% for women. As the statisticians who applied these new definitions stated:

By simply changing the overweight cutoffs, the estimated number of overweight adults increases from 61.7 million (BMI ≥ 27.8 and 27.3) to 97.1 million (BMI ≥ 25.0), representing a difference of 35.4 million overweight adults. This example calls attention to the actual effect that a shift in BMI criteria can have on determining the population at risk. (Kuczmarski & Flegal, 2000: 1078)

An increase of over 35 million adults was a major shift and, although this quote appeared in an academic article about bodyweight classifications, it has become part of the wider public discussion about obesity as it is regularly cited by critical authors to highlight the arbitrary and constructed nature of such criteria (Bacon, 2008: 148-51; Oliver, 2006: 22). Researchers working in this field were very aware of this point,

but the BMI had important practical advantages for obesity science, and it had now become embedded in practice, notably by being incorporated into the results of studies such as WHO MONICA.

Discussion

Obesity and overweight were initially defined using a variety of classificatory schemes and indices, and this caused two important problems for researchers. Firstly, varying definitions and measures (often in different units) made it hard to compare the results of different studies (Bray, 1987: 19; DHSS/MRC, 1976: 8). Secondly, using percentage deviation from average body weight (like the ideal weight tables) meant that, if relative proportions stayed the same, then the same number of people would be defined as overweight or obese, even if the whole population gained significant amounts of weight. An absolute measure, such as BMI, (which does not vary with changing prevalence) was more useful in a situation where the prevalence within a population was changing, especially if the rationale of such an index was to track this change (Keys et al., 1972).

As Hacking (2006a: 88) points out, another advantage of the BMI was that it is based on data that is relatively cheap to collect, particularly compared to measuring body fat which is technically complex, and, therefore, very expensive (Garrow, 1988: 28; see also O'Connell, 1993). The development of the BMI allowed epidemiologists to create large data sets using readily available, and therefore cheap, data. In addition, because height and weight have been routinely collected in many areas of medical research, existing data sets, such as those of the Framingham Study, could be easily converted

into this new index. The adoption of this simple numerical index allowed epidemiologists, and other researchers, to directly compare the results of different research studies, and thus investigate, describe and quantify trends in changes in population weight between regions, countries and across time.

The use of these standard BMI- based definitions made it possible to compile and compare increasing amounts of population-level data on average body weights. Much early obesity science writing argued from a fairly limited evidence base that excess body weight was an important public health problem. Large-scale data was not readily available because governments did not routinely collect statistics about weight trends among their populations until the 1960s and 1970s (Oddy et al., 2009: 225). Because of this, British authors made heavy use of American sources, such as the Metropolitan Life ideal weight tables or the Build and Blood Pressure study of 1959, combined with the results of a few small-scale British studies. However, this lack does not seem to have affected the credibility of these researchers, and, obesity science appears to have become well-established in the UK and Europe by the 1990s. At this time, more results were also being generated by large-scale epidemiological studies, and one set appeared to show a big increase in the prevalence of obesity and overweight (Kuczmarski et al., 1994). After these figures were widely reported, obesity started to be described as an epidemic in both the medical and popular press (Pi-Sunyer quoted in Pringle, 1994). This new framing of obesity was largely made possible by the gradual adoption and standardising of the BMI definitions. With an easily handled numerical measure such as BMI, it was much simpler to construct prevalence rates for overweight and obesity, and, therefore, to monitor and describe secular changes within populations, and differences between populations.

The use of BMI-based definitions also facilitated the diagrammatic representation of increasing rates of overweight and obesity. The spread of infectious diseases has often been represented by mapping the geographical spread of increases in prevalence rates. In the late 1990s this method was applied to increasing rates of obesity and overweight in a series of slides produced by the Centers for Disease Control (CDC). This animation shows an increasing number of the American states going from blue to red over a period of 15 years, as average rates of obesity increased to levels above 30% (CDC, 2010). It has been argued that this memorable and widely publicised animation – first produced in 1999, but still readily available online – was one of the most important factors in establishing the ‘fact’ of obesity as an epidemic (Oliver, 2006: 40-3). It is a vivid illustration of a more general co-production (Jasanoff, 2005) of the BMI as measurement and definition of obesity, and the ‘epidemicity’ of obesity. Without the BMI to provide a simple way of turning data into a stark representation of obesity rates, it would have been much harder to argue credibly that obesity was increasing to the extent that it could be labelled as an ‘epidemic’.

In summary, the development of the BMI was an important means of standardisation which solved concrete research problems, led to the creation of new types of knowledge and new ways of working and, therefore, facilitated the development of obesity science. My research examines the relatively new empirical area of British and American chronic disease epidemiology and brings together existing sociological work on standards with theoretical approaches from STS to demonstrate the ways in which this standard was co-produced with the phenomenon that it measured. The adoption of the BMI, and standard cut-off points, was crucial in the framing of obesity

as an epidemic: it allowed for the creation of large datasets tracking population level changes in average bodyweights, and the diagrammatic representation of these changes. These two new entities made it possible for researchers in this field, and others, to argue that obesity should be described as an epidemic.

Although the development of the BMI made this framing possible, these changes in average bodyweights are not solely an artefact of this measure. In certain populations, these are real and significant changes, but the BMI is only one possible way of measuring them and assessing the possibility of increased risks to health: other accepted measures of cardiovascular risk include waist circumference, blood pressure or fasting glucose levels. Moreover, an account of the work involved in developing the BMI as a standard definition of excess bodyweight and its tendency to proliferate demonstrates the social assumptions embedded in its use e.g. that weight gain is not an acceptable aspect of ageing, or that all population groups experience increased risk of cardiovascular disease at the same BMI ranges. The adoption of the BMI, although useful for researchers and policymakers, has led to an increased focus on bodyweight as an index of health. Its widespread use in both medical and non-medical discourse, points to the need for further research analysing the knowledge and practices embedded in this framing, and those, such as health inequalities within populations, that are largely excluded.

¹ The most important of these were Baird, IM and Howard, A (eds) (1969) *Obesity: Medical and Scientific Aspects: Proceeding of the First Symposiums of the Obesity Association*; OHE (1969) *Obesity and Disease*; DHSS/MRC (1977) *Research on Obesity*; Garrow, J.S (1978) *Energy Balance and Man*, Garrow, J.S. (1988) *Obesity and Related Disease*; West (1994) *Obesity*; Department of Health (1995) *Obesity: Reversing the Increasing Problem of Obesity in England*; WHO (1995) *Physical Status: The Use and Interpretation of Anthropometry*; Scottish Intercollegiate Guidelines Network (1996) *Obesity in Scotland: Integrating Prevention with Weight Management*; British Nutrition Foundation (1999) *Obesity*; and WHO (2000) *Obesity: Preventing and Managing the Global Epidemic*.

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